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 with proteins studied by carbon-13 nuclear magnetic
 resonance spectroscopy.
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AB In order to understand the modifications of proteins produced by
 aldehydes
 of lipid peroxidation, [1-13C]-2(E)-hexenal, [1-13C]-4-oxopentanal, and
 a mixture of [1-13C]- and [2-13C]-4-hydroxynon-2(E)-enal were synthesized
 and the reaction of each of the labeled aldehydes with bovine serum albumin
 was analyzed by 13C NMR spectroscopy. Protein nucleophiles add to the
 3-position of hexenal, and the resulting propanal moieties appear to
 undergo aldol condensation, form imine cross-links with lysyl residues,
 or lead to pyridinium rings. During the reaction of 4-oxopentanal with the
 lysyl residues of bovine serum albumin, only 1-alkyl-2-methylpyrrole and
 a possible intermediate leading to the pyrrole were observed.
 Hydroxy-pyrrolidine cross-links such as 25 could not be detected, leaving
 the pyrrole as the mediator of protein **cross**-linking. The
Michael adducts are the major products in the reaction between
 4-hydroxynon-2-enal and proteins. They exist almost exclusively in the
 cyclic hemiacetal form and do not appear to cross-link through imine
 formation with lysyl residues. A minor pathway involves the reaction of
 4-hydroxynon-2-enal with the lysyl amino groups of protein resulting in
 2-pentylpyrrole adducts that may mediate protein **cross**-linking.
 The **Michael** adducts appear not to be the direct source of the
 pyrrole, but the imine 32 and the enamine 35 are likely intermediates
 toward the five-membered ring.

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